CASCaDE

Collaborative Artifact, Specification, Context and Data Exchange
a standardization initiative in support of Digital Engineering Interoperability

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- Problem Statement: Why CASCaDE?
- CASCaDE Objectives and Scope
- CASCaDE Use-Cases and Architecture
- Stakeholders
- Standardization Timeline
- Outlook
- Frequently Asked Questions

Problem Statement: Why CASCaDE?

Increasing use of **engineering data** in **downstream processes** through **Digital Thread** and **Digital Twins**	Need to enable **cross-company digital collaboration** using standards
Model-Based Engineering practices **emerging** in the industry: **MBSE**, **MBD**, **MBAcq**, etc.	Need to **collaborate** on **model elements,** not **documents**
Increasing shares of **Electrics/Electronics** and **Embedded Software** besides **Mechanics**	Need for **cross-domain collaboration**
Digital use of data emerging, **human use of data** still **persisting**	Need to support both **digital availability** and **human readability**
Different **engagement levels** at **different stages** across the product lifecycle	Need to support packages **inside IT systems**, **data spaces** and **document-based containers**,

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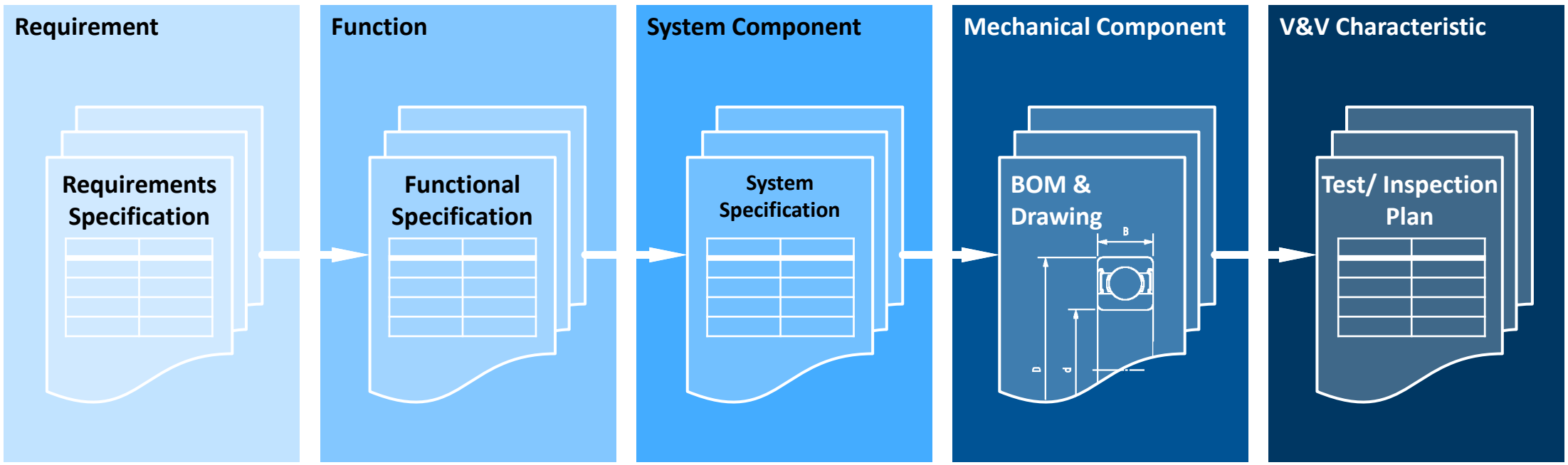
Increasing use of **engineering data** in **downstream processes** through **Digital Thread** and **Digital Twins**

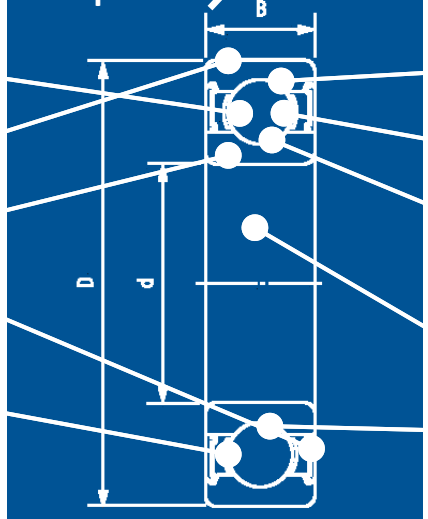
Need to enable **cross-company digital collaboration** using standards



Problem Statement: Why CASCaDE

Model-Based Engineering practices **emerging** in the industry: **MBSE**, **MBD**, **MBAcq**, etc.

Need to **collaborate** on **model elements,** not **documents**

Requirement (Requirements Specification)	Function (Functional Specification)	System Component (System Specification)	Mechanical Component (BOM & Models)	V&V Characteristic (Inspection Plan)
Guide rotating shaft	Absorb radial forces	Rolling elements		Inspect outer guide roughness
Handle slight unbalance	Absorb axial forces	Rolling elements outer guide		Inspect ball dims & roughness
Medium, uniform velocity	Seal rolling elements	Rolling elements inner guide		Inspect inner guide roughness
Keep out splash water or dust	Prevent the rolling elements from touching each other	Sliding seal		Verify vibration & noise specs
Ensure safe operation	Rolling elements evenly distributed around the circumference	Cage		Verify long-term wear & tear

Problem Statement: Why CASCaDE

Increasing shares of **Electrics/Electronics** and **Embedded Software** besides **Mechanics**

Need for **cross-domain collaboration**

Requirement (Requirements Specification)
- Guide rotating shaft
- Handle slight unbalance
- Medium, uniform velocity
- Keep out splash water or dust
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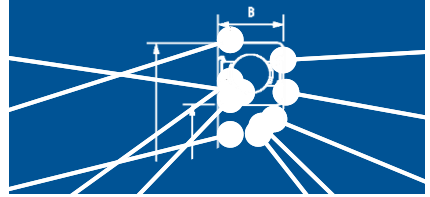
Function (Functional Specification)
- Absorb radial forces
- Absorb axial forces
- Seal rolling elements
- Prevent the rolling elements from touching each other
- Rolling elements evenly distributed around the circumference

System Component (System Specification)
- Rolling elements
- Rolling elements outer guide
- Rolling elements inner guide
- Sliding seal
- Cage

Mechanical Component (BOM & Models)



Electric/Electronic Component

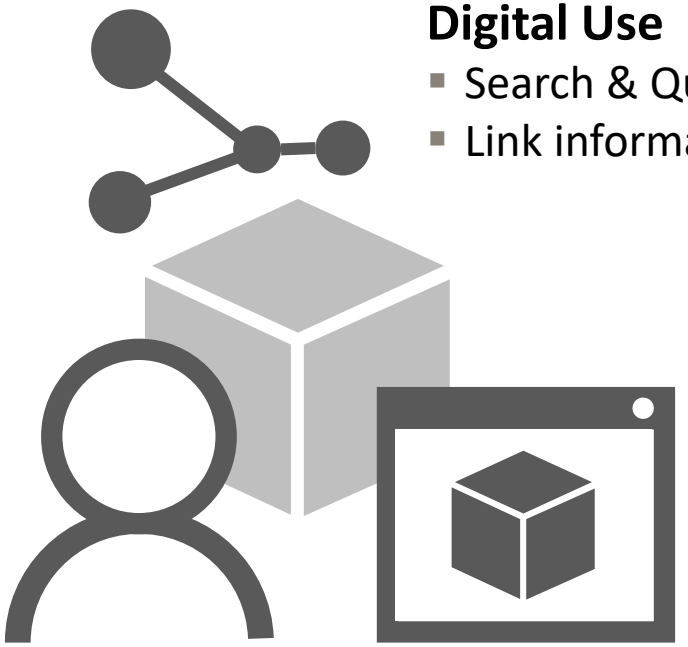
Software Component

V&V Characteristic (Inspection Plan)
- Inspect outer guide roughness
- Inspect ball dims & roughness
- Inspect inner guide roughness
- Verify vibration & noise specs
- Verify long-term wear & tear

Problem Statement: Why CASCaDE

Digital use of data emerging, human use of data still **persisting**

Need to support both **digital availability** and **human readability**



Digital Use

- Search & Query Information through APIs or URLs
- Link information from/to other Sources

Human Use

- View Information
- Comment and Annotate Model Elements
- Browse & Navigate Information
- Share Links

Tool-based Use

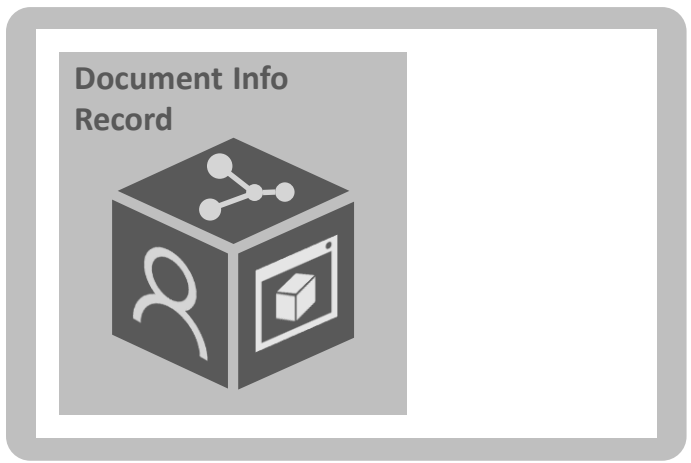
- Open Standardized Model Data in Authoring Systems
- Modify or Enhance existing Models

Problem Statement: Why CASCaDE

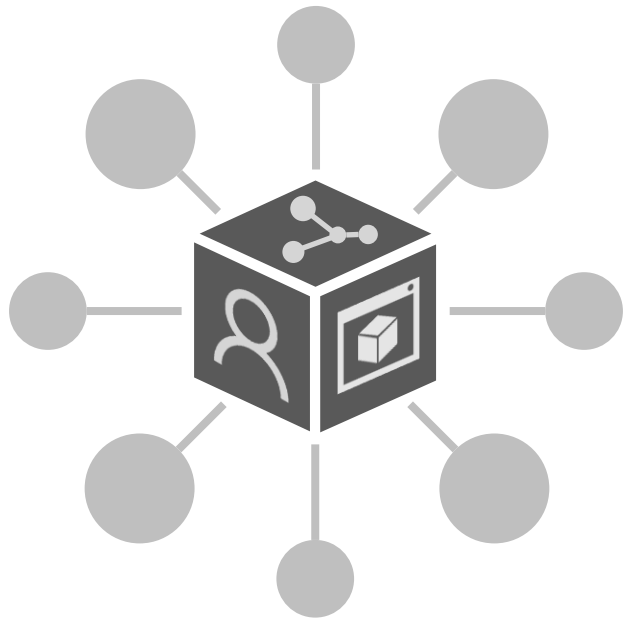
Different **engagement levels** at **different stages** across the product lifecycle

Need to support packages as **document-based containers**, **inside IT systems**, and **data spaces**

Package in File Data Exchange & Archiving



Package/Scope in Data Management Systems as Baselines



Package/Scope in Data Spaces for immersive Collaboration

CASCaDE Architecture

Package/Scope

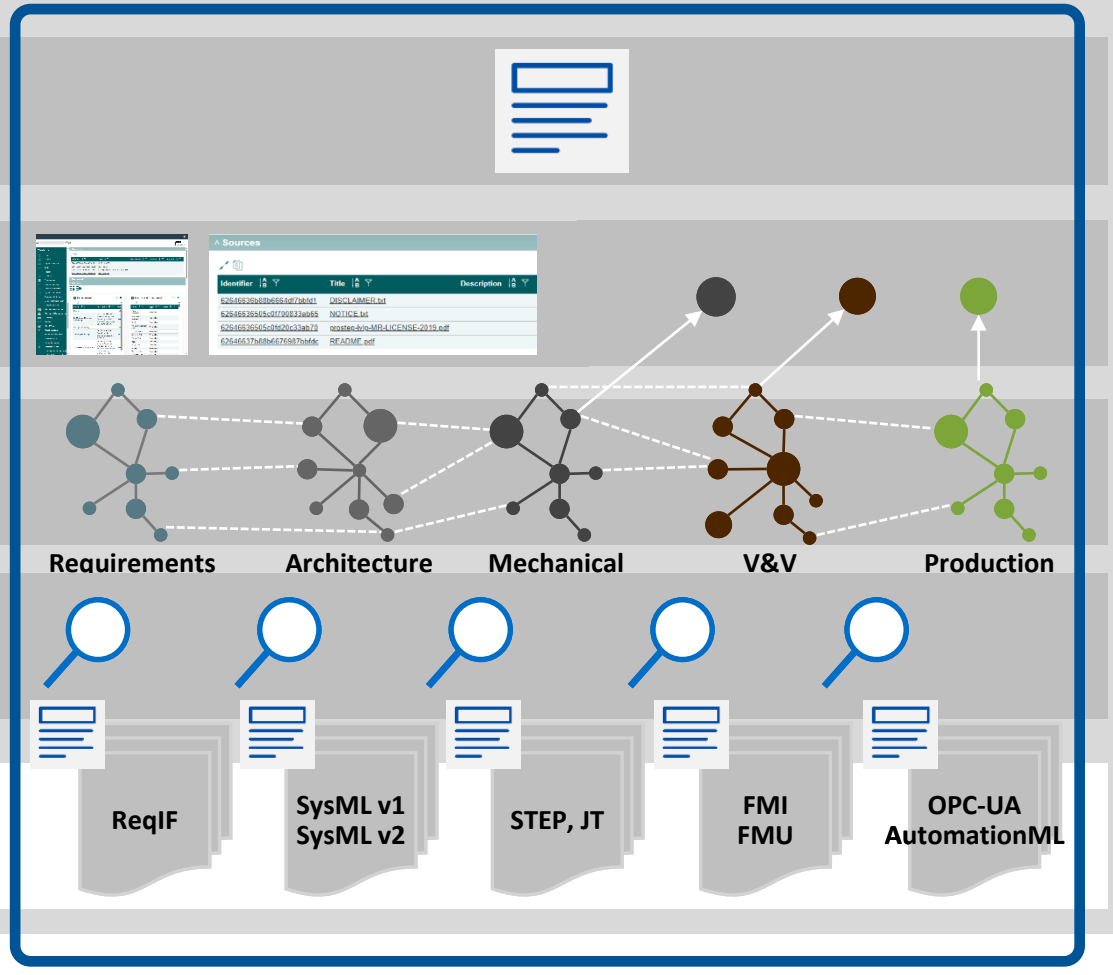
Package & Model Meta Data

Visualization & API Access

Ontology & Schema

Translation

Models



Need to enable **cross-company digital collaboration** using standards

Need to **collaborate** on **model elements,** not **documents**

Need for **cross-domain collaboration**

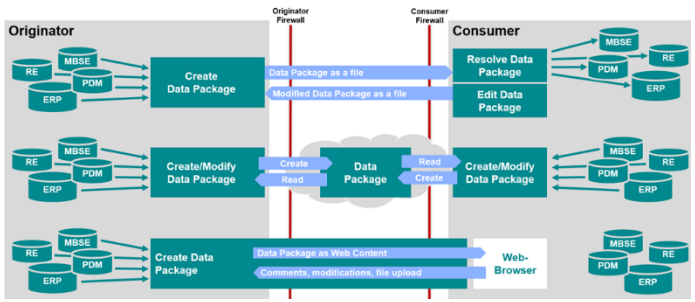
Need to support packages **inside IT systems**, **data spaces** and **document-based containers**,

Need to support both **digital availability** and **human readability**

Problem Statement: Why CASCaDE

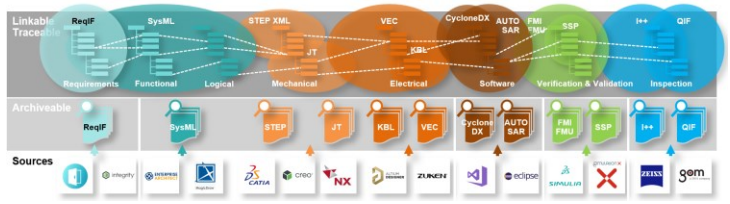
Collaboration scope

- Support company **internal and external collaboration** with suppliers
- **Support synchronous** (Data Sharing) **and asynchronous interactions** (Data Exchange)



Respect data and tools diversity

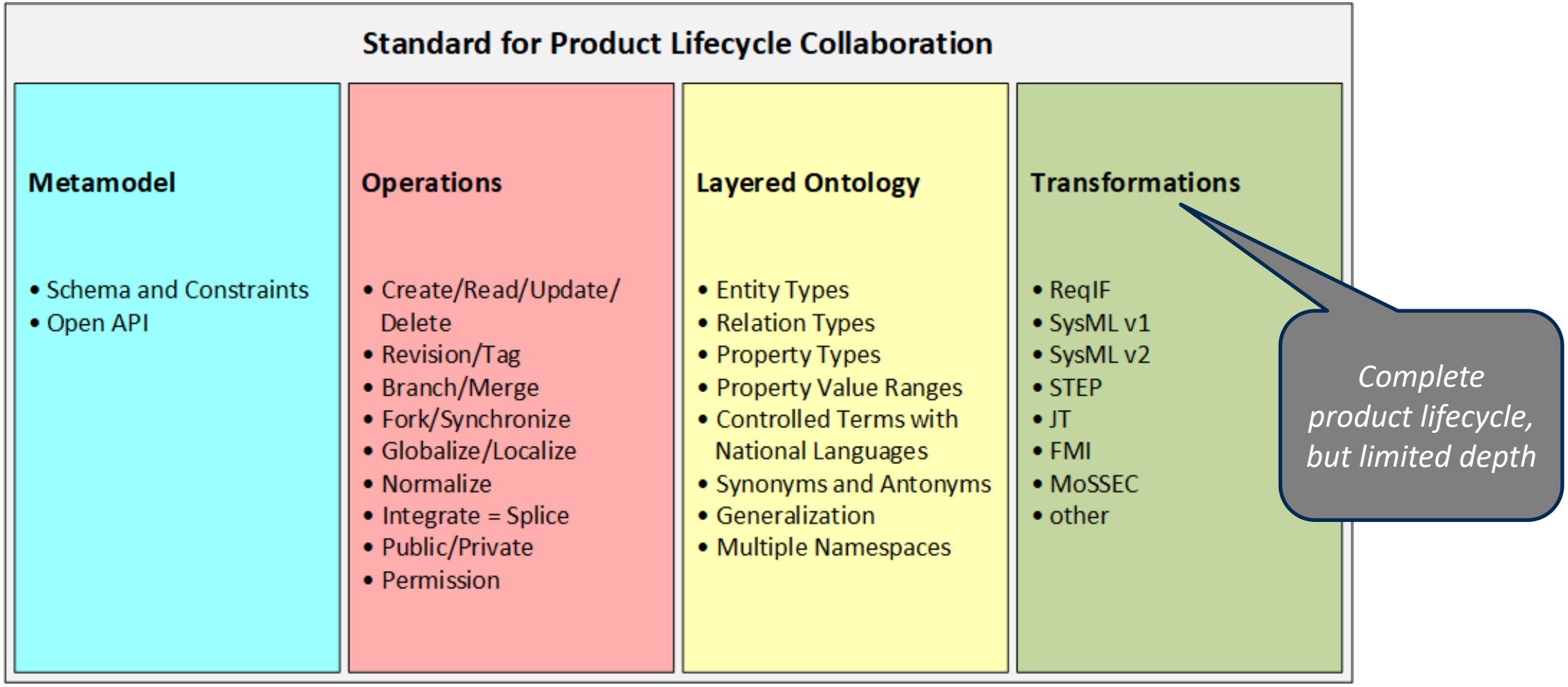
- **Existing tools and formats tend to expand across their original scope** and boundaries, thus invading adjacent disciplines that already have their solutions.
- **Respect and keep the variety of authoring tools and data formats** involved in interdisciplinary DE unchanged: Pick up the data from where they are.



Semantic integration

- Integration of data/information used in the collaboration
- Integration of
  - Technical data: **OMG ReqIF, OMG SysML v2, STEP AP242, FMI**
  - Context metadata: **ISO STEP, MoSSEC, LOTAR P5XX**
- Uses **layered ontology structure** combining the best from both **SpecIF (GfSE) and the Digital Data Package (prostep ivip)**

Scope of Proposals Sought



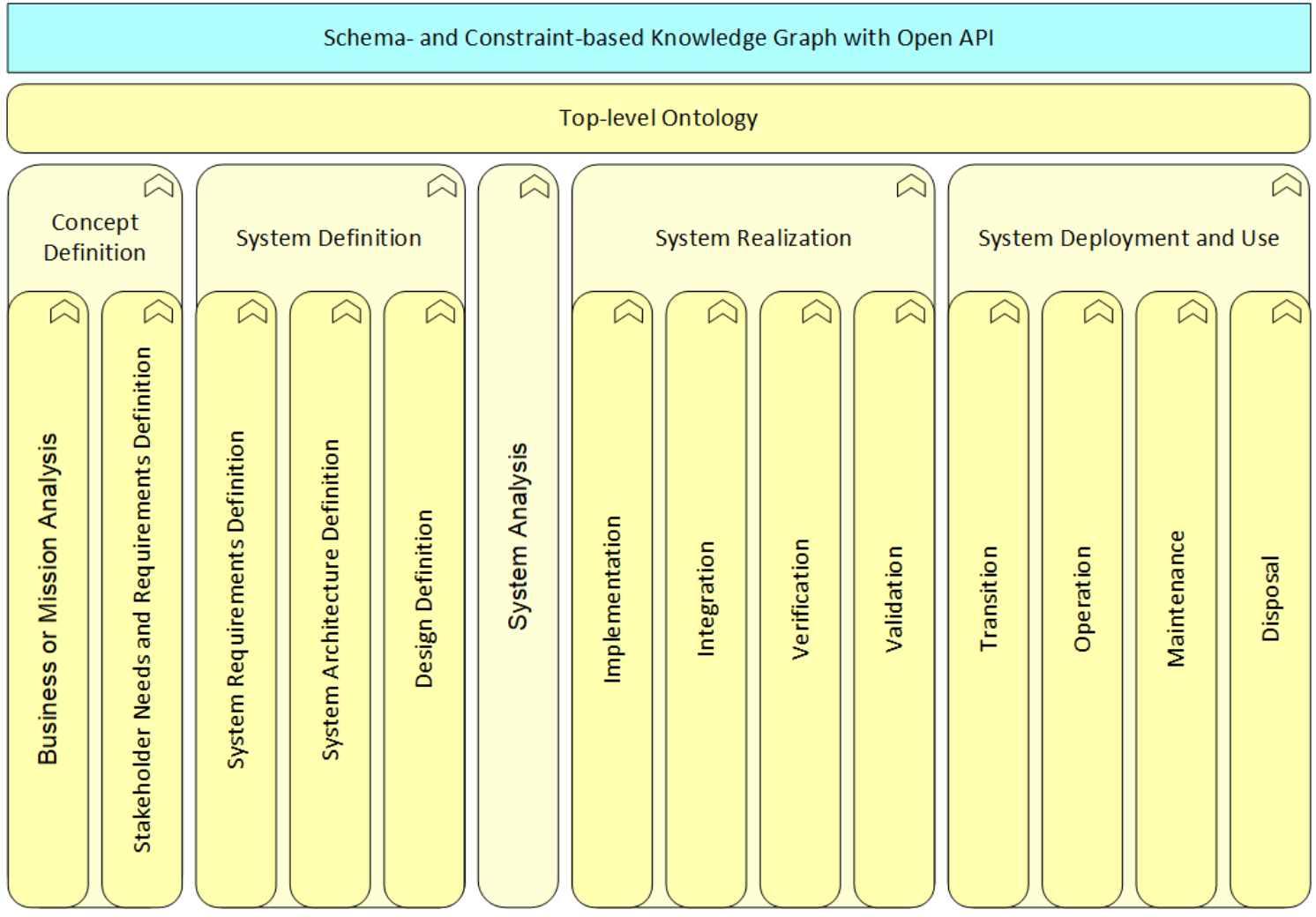
The CASCaDE Standard is Modular

Syntax (blue)

- Knowledge Graph with nodes (artifacts/activities) and edges (relations)
- Constraints

Semantics (yellow)

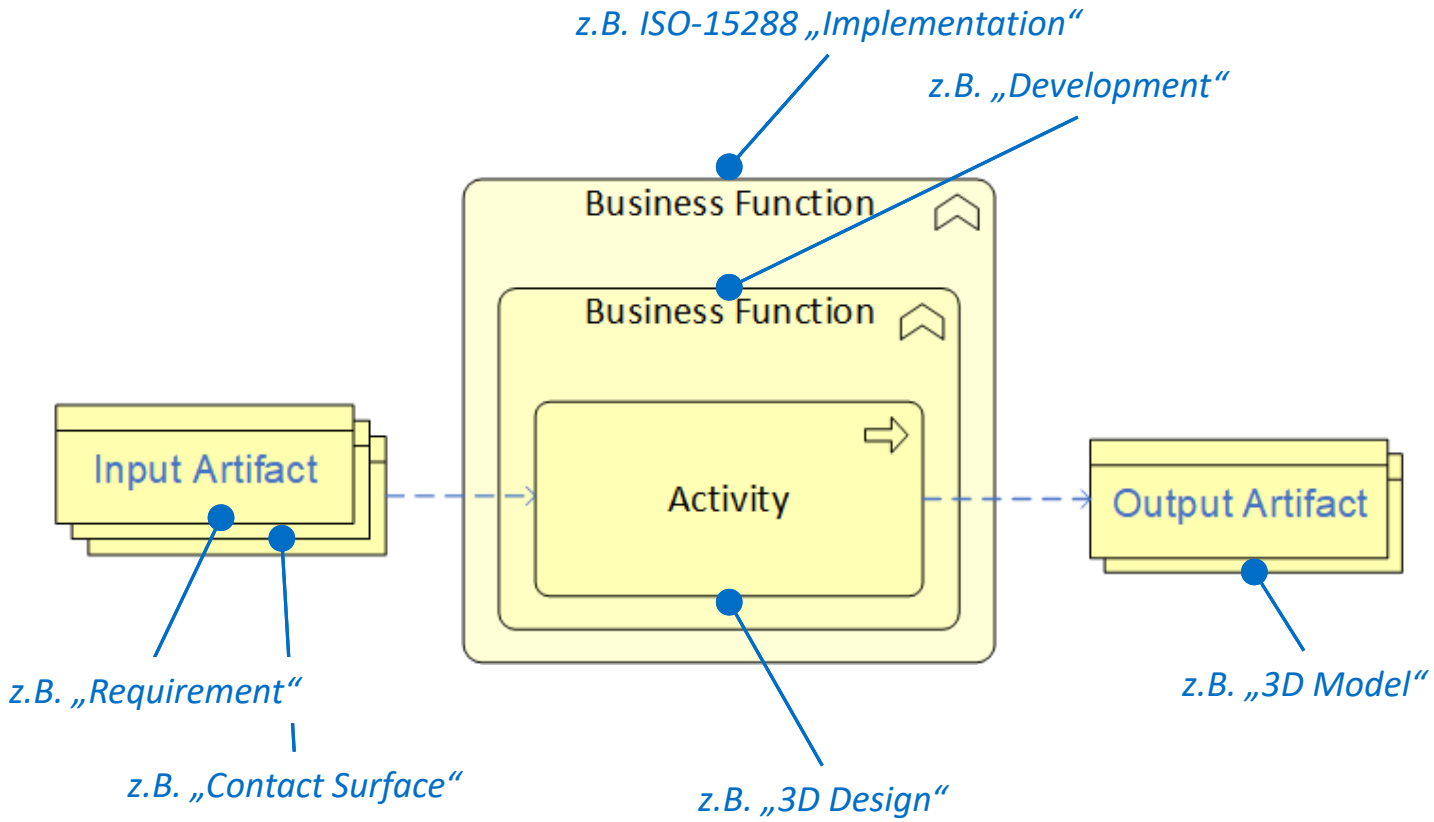
- Terms for activities and artifacts (data objects) at the input and output
- Terms for relations



Define Terms for Activities and Artifacts (Data Objects)

The standard shall include a hierarchical structure of terms with synonyms and other relations (“Ontology”):

- Business functions broken down to activities
- Work products = artifacts = data objects



Precursor Technologies

GfSE Specification Integration Facility (SpecIF)

- Combine partial models to a graph
- Simple Schema and Constraints
- Successful real-world projects in Enterprise Architecture

Prostep ivip Digital Data Package (DDP)

- Comprehensive analysis of standards and data formats in the aerospace and automotive industries
- Naming recommendation for artifacts and activities relevant for collaboration
- Test data successfully exchanged between multiple software products

Precursor-Technology
SpecIF - Specification Integration Facility (GfSE)

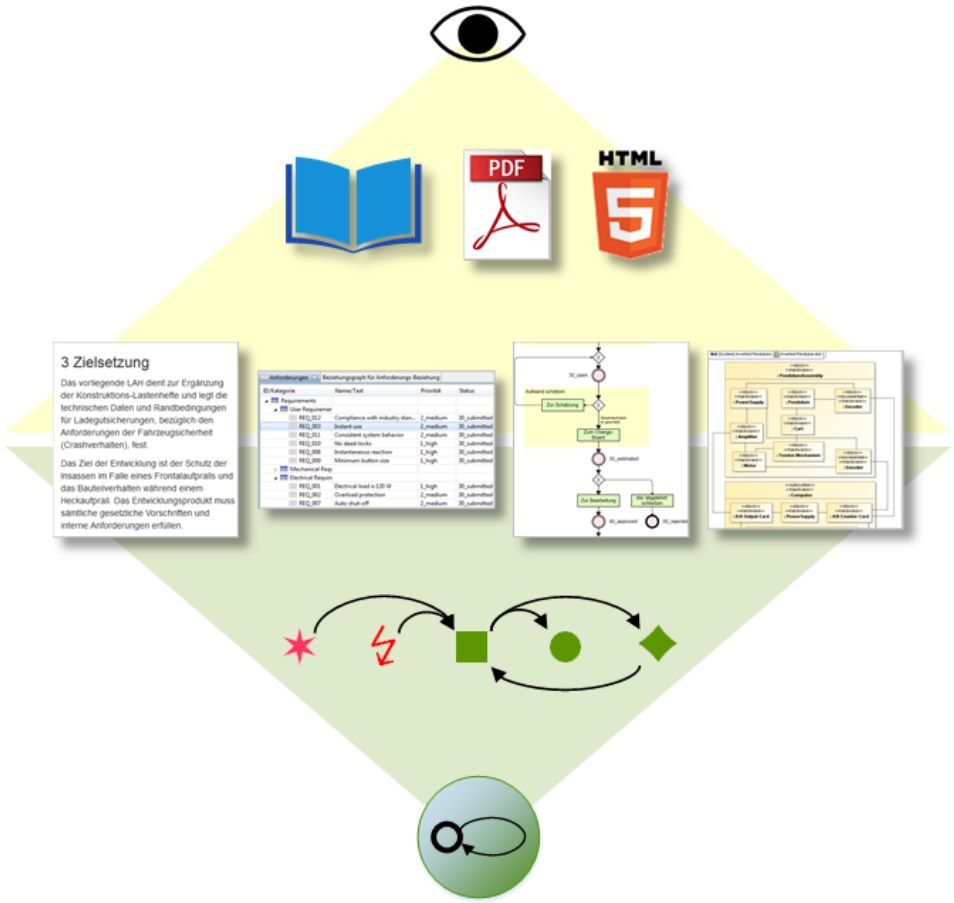
SpecIF
Specification Integration Facility

Medium/Format
(The Presentation)

Notation
(The Visible)

Integrated Model
(The Meaning)

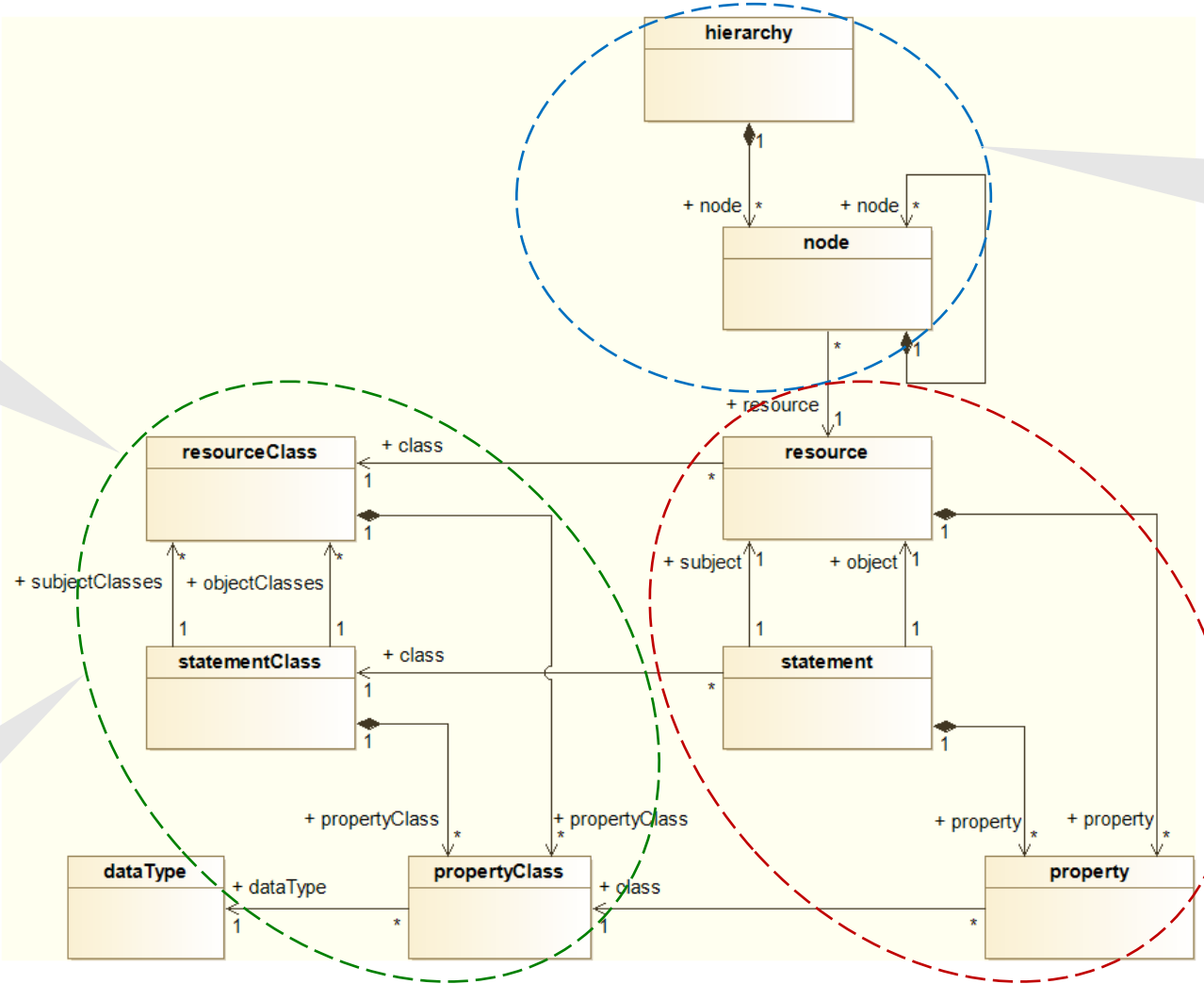
Objects and Relations
(The Persistence)



A SpecIF data set contains both the the types („model“) and the instances („data“ = „payload“)

SpecIF model with Resource- and Statement-Classes

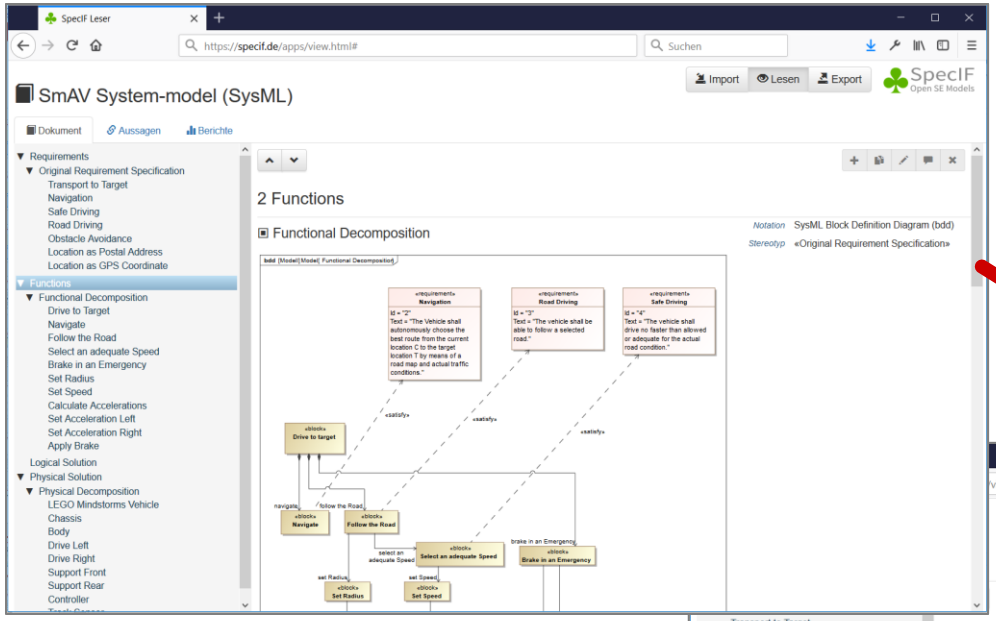
Classes correspond to the Ontology (can be modified at runtime)



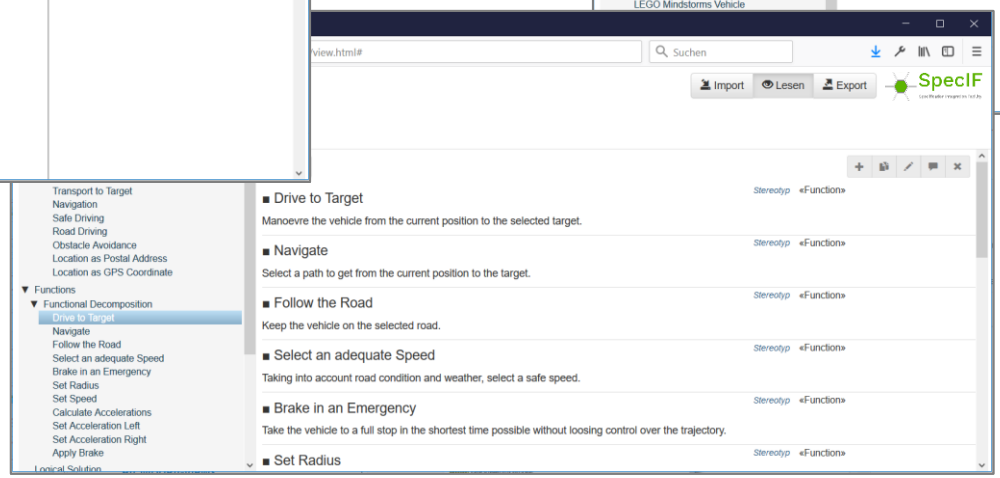
Hierarchical ordering of Resources (→ Outline, BoM or similar)

SpecIF data (payload) with Resources and Statements

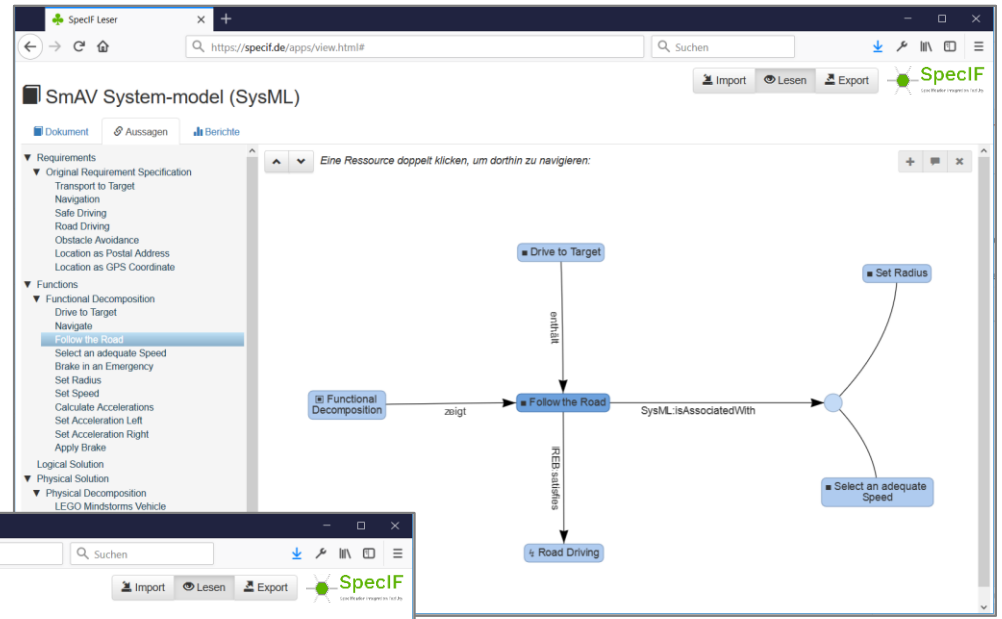
SpecIF Example: Small Autonomous Vehicle (SysML)



Alle Modelidiagramme

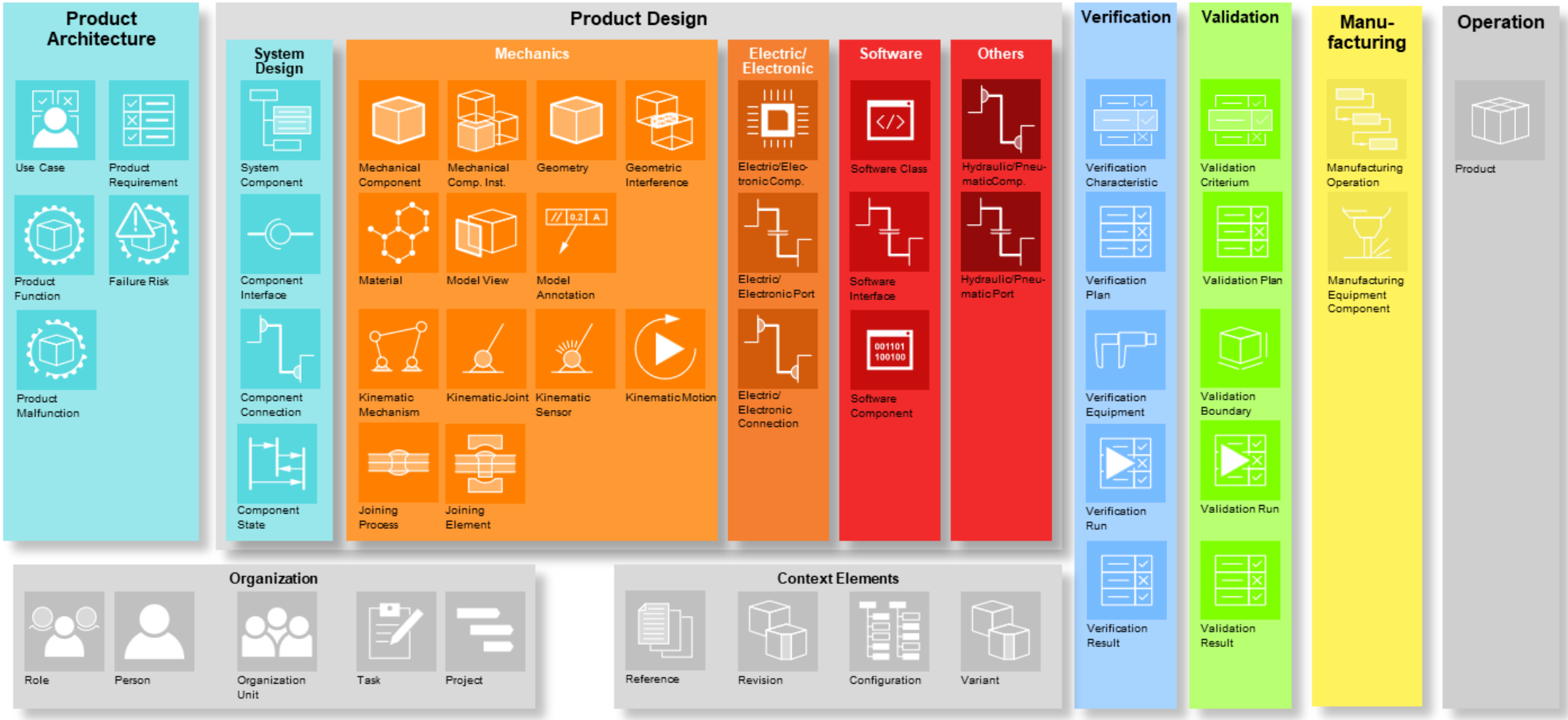


Alle Modellelemente („Resources“)

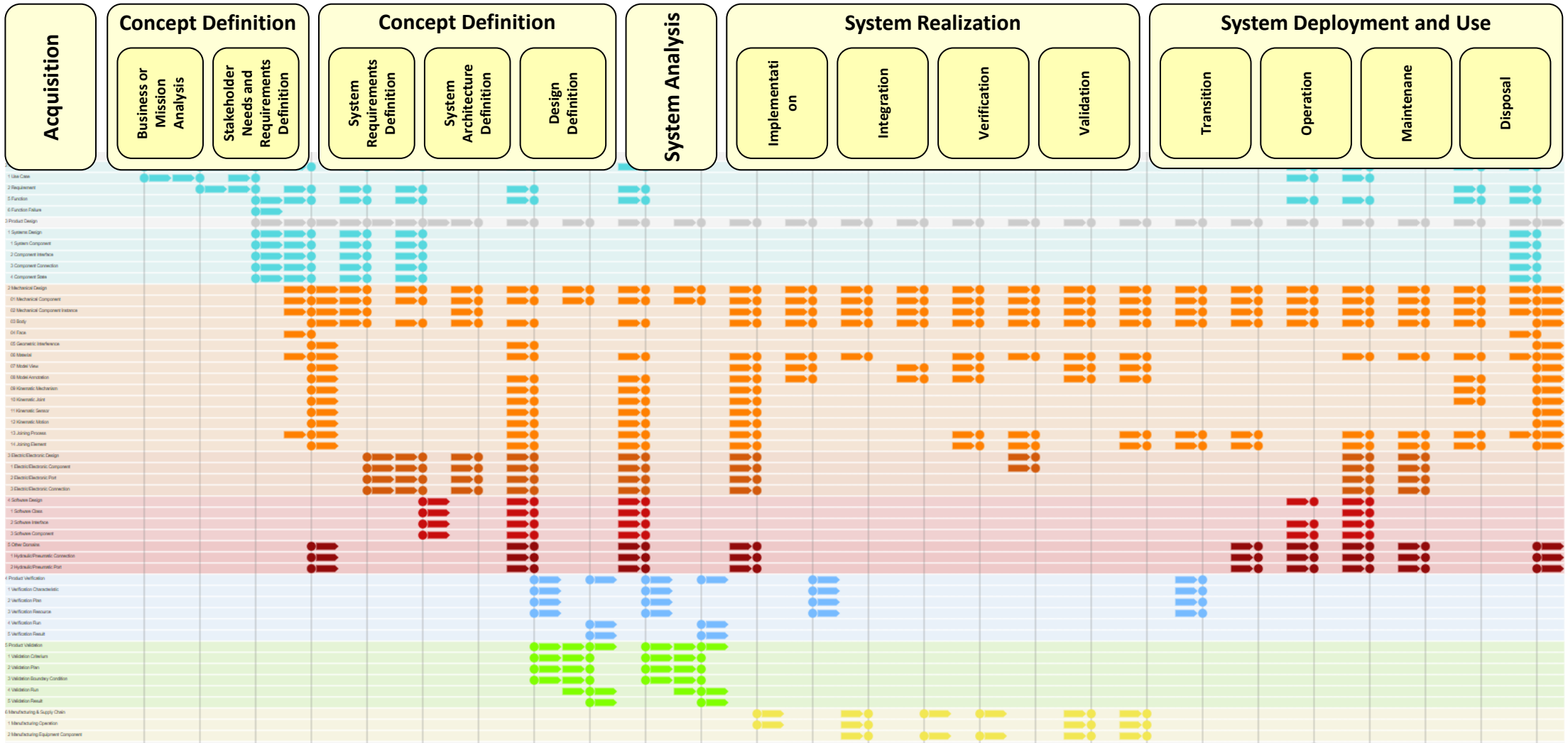


Alle Beziehungen („Statements“)

Scope of the CASCaDE Ontology

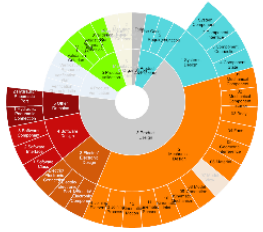


Different Information Requirements per Use-Case

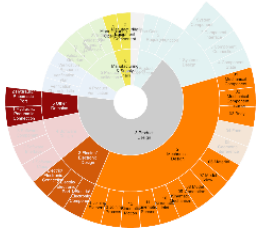


Different Information Requirements per Use-Case

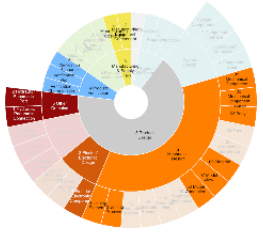
1 Product Planning



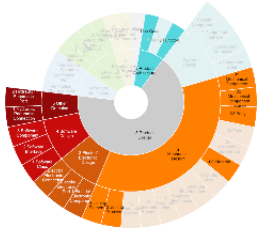
2 Product Development



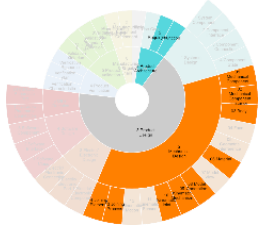
3 Production Development



4 Manufacturing & Supply Chain

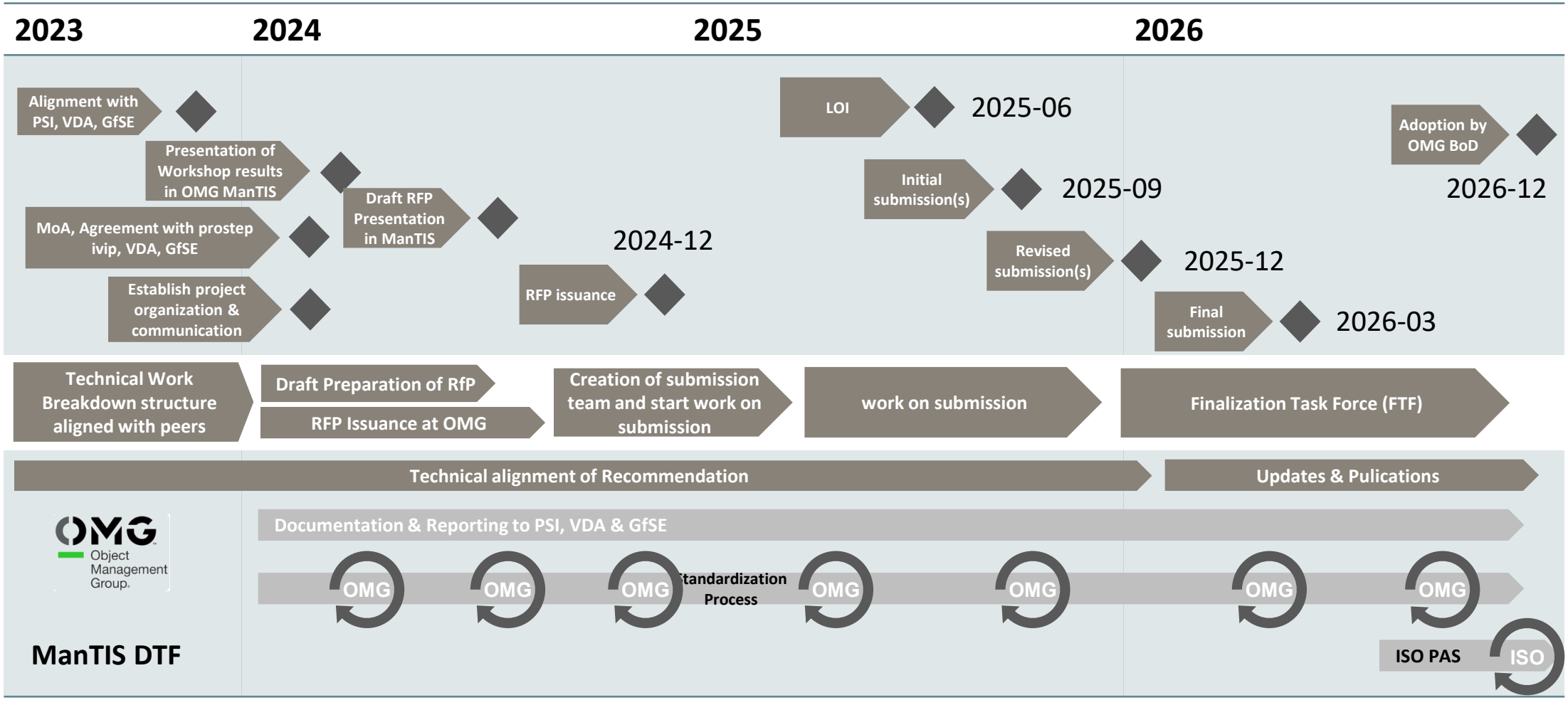


5 Product Operation



6 Long-Term Archiving

Standardization Timeline



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